ORGANIC EL ELEMENT AND ITS MANUFACTURE

Patent number: JP2000164355

Publication date: 2000-06-16

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Classification:

- international: H05B33/10; C23C14/12; C23C14/32; H05B33/14; H05B33/22

- european:

Application number: JP19980335895 19981126

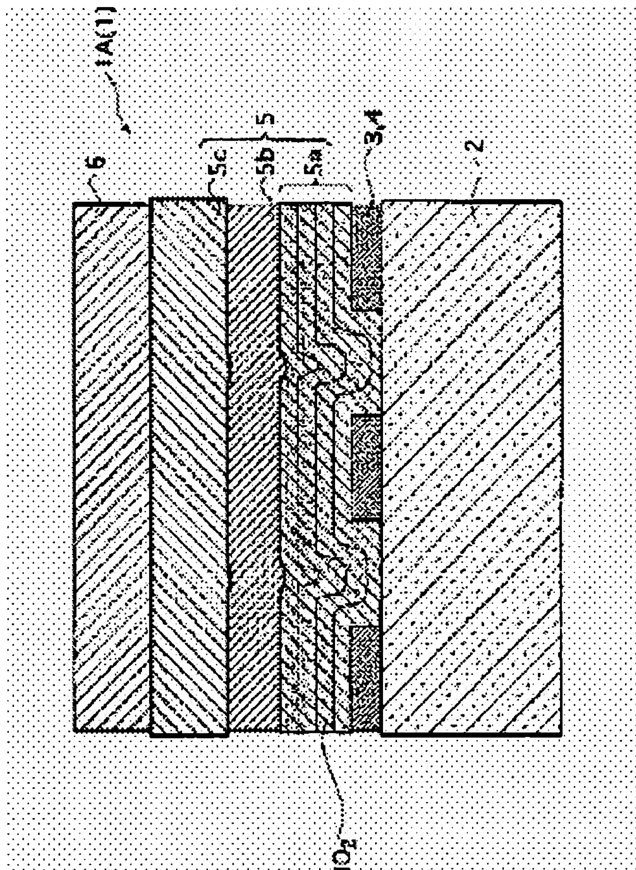
Priority number(s):

Also published as:

JP2000164355 (A)

Abstract of **JP2000164355**

PROBLEM TO BE SOLVED: To reduce power consumption even when copper phthalocyanine (CuPc) organic film is made thick, to drive it with a lower voltage for low power consumption, to improve the transmission factor of the red section of visible light through the CuPc organic film and to obtain a desired luminescence color. SOLUTION: An anode 4 made of a transparent conductive film 3 in the prescribed pattern shape is formed on a glass substrate 2. A hole injection CuPc organic film 5a is formed on the anode 4 as a plasma polymerized film having an improved transmission factor of red luminescence at the thickness of 1 &mu m or above by an ion plating method. The CuPc organic film 5a is exposed to the atmosphere of NO2 which is an electron-acceptive gas after it is formed, and it contains NO2 in it. The conductivity of the CuPc organic film 5a is increased, and hole injection efficiency is stabilized and improved. An &alpha -NPD organic film 5b and an Alq3 organic film 5c are formed in this order on the CuPc organic film 5a to obtain an organic layer 5, and a cathode 6 is formed on the Alq3 organic film 5c. A container section is fixed to the peripheral portion of the glass substrate 2 to protect the anode 4, organic layer 5 and cathode 6.



JPO Computer Translation of JP 2000-068068

http://www4.ipdl.ncipi.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=2000-068068
10-16-04

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the organic EL device which consisted of thin films of said organic electroluminescence compound, and its manufacture approach using the electroluminescence (it is called Following EL) of an electron and the organic compound ingredient which emits light by impregnation and recombination of a hole (electron hole).
[0002]
[Description of the Prior Art] An organic EL device is a display device which displays using emission (fluorescence and phosphorescence) of the light at the time of having the laminated structure whose thin film containing a fluorescence organic compound was pinched between cathode and an anode plate, making an exciton (exciton) generate by making an electron and a hole pour in and recombine with said thin film, and this exciton deactivating.
[0003] Drawing 9 (a) - (g) is the sectional side elevation showing this kind of the conventional configuration and conventional production process of an organic EL device.
[0004] The transparence electric conduction film 33 which consists of ITO (Indium Tin Oxide) is formed on the glass substrate 32 which has the insulation and transparency which show this organic EL device 31 to drawing 9 (a). Membranes are formed on a glass substrate 32, and pattern NINGU of this transparence electric conduction film 33 is carried out, and it forms the anode plate 34 in a predetermined pattern configuration as shown in drawing 9 (b).
[0005] On the anode plate 34, the laminating of the organic layer 35 by the thin film of an organic compound ingredient is carried out. Copper-phthalocyanine (CuPc) organic film 35a as a hole impregnation layer formed on the anode plate 34 which shows the organic layer 35 to drawing 9 (c), Alpha-NPD as a hole transportation layer formed on CuPc organic film 35a shown in drawing 9 (d) (with Bis (N-(1-naphtyl-N-phneyl) benzidine) organic film 35b) It is formed by the three-tiered structure with tris (8-quinolinolato) aluminum (Alq3) organic film 35c as an electronic [a luminous layer-cum-] transportation layer formed on alpha-NPD organic film 35b shown in drawing 9 (e).
[0006] As shown in drawing 9 (f), on the organic layer 35 (Alq3 organic film 35c), the cathode 36 which consists of metal thin films, such as aluminum-Li, is formed.
[0007] As shown in drawing 9 (g), into the periphery part of a glass substrate 32, the container section 37 as a sealing member has fixed with adhesives in the dry ambient atmosphere by inert gas (for example, dry nitrogen) and the dried air which removed moisture as much as possible.
[0008] In the organic EL device 31 constituted as mentioned above, an electrical potential difference is impressed between an anode plate 34 and cathode 36, and constant current is passed. Thereby, an electron is poured in for a hole from cathode 36 from an anode plate 34 to the organic layer 35, respectively. And the electron and hole which were poured in recombine, an exciton is generated and a desired display is made by emission of the light at the time of this exciton deactivating. Luminescence in that case is observed from a glass substrate 32 side through the anode plate 34 by the transparence electric conduction film 33.
[0009]
[Problem(s) to be Solved by the Invention] By the way, in the organic EL device 31 constituted as mentioned above, it has CuPc organic film 35a as a hole impregnation layer of the organic layer 35. This CuPc organic film 35a has the property that a voltage-current property differs from an electrical-potential-difference-brightness property according to that thickness. That is, when making light emit by the fixed current or fixed brightness, the property that the thickness of the CuPc organic film takes for becoming thin, can make driver voltage low, the CuPc organic film takes for becoming thick conversely, and driver voltage becomes high is shown.

[0010] The configuration of the organic EL device of drawing 9 is adopted as drawing 6 and drawing 7 , and each property at the time of forming the thickness of the CuPc organic film by 20nm and 1000nm is shown in them. The case where the direction at the time of forming membranes by 20nm forms the thickness of the CuPc organic film by 1000nm shows that it can do low [driver voltage] so that clearly also from this drawing.
[0011] 15mA/cm2 [concretely, required to drive an organic EL device when it sees with a current] At 1000nm, they are 15 mA/cm2 to the thickness of the CuPc organic film needing about 5.8v driver voltage by 20nm, as shown in drawing 6 in order to pass a current. It could not take and was not able to put in practical use as a component.
[0012] moreover, 400 cd/m2 generally needed as a display device when it sees by brightness in order to obtain brightness, it is shown in drawing 7 -- as -- the thickness of the CuPc organic film -- 20nm -- about 6.2 -- it was impossible to have obtained 400 cd/m2 by 1000nm to needing about V driver voltage.
[0013] Therefore, in order to obtain high brightness more with the organic EL device 31 by the configuration of drawing 9 , thickness of the CuPc organic film had to be made thin with 20nm.
[0014] By the way, the organic electroluminescent device by the structure which inserted between an anode plate and cathode and carried out the laminating of an electron hole injection band and the organic emission band region to JP,59-194393,A (JP,6-32307,B) as an organic layer so that thickness might not exceed 1000nm is indicated.
[0015] However, also in the above-mentioned equipment, there are problems including the problem by the CuPc organic film mentioned above as shown below. That is, when the anode plate which becomes the substrate of an organic layer is formed by ITO, the front face will turn into a dozens of nm concave convex including the projection of the letter of a spike. Moreover, it is a concave convex although the front face of the glass substrate which becomes the substrate of ITO is also loose.
[0016] And on the glass substrate which has a concave convex, ITO was formed, the anode plate was formed, and when the laminating of the electron hole injection band which makes an organic layer on ITO which has a concave convex further and an organic emission band region, and the cathode was carried out to order and membranes were formed, there was a possibility of between an anode plate and cathode having short-circuited electrically by the projection of the letter of a spike of ITO, and inviting poor insulation.
[0017] Moreover, if an organic layer and cathode are formed in order on an anode plate as it is when the location to vapor-deposit, surrounding detailed dust, etc. adhere to the front face of the anode plate already formed, the clearance by dust etc. cannot be filled completely. For this reason, it is easy to cause the electric short-circuit between an anode plate and cathode through that clearance. And when the dust adhering to an anode plate has conductivity, possibility of making between an anode plate and cathode short-circuiting electrically through this dust is high.
[0018] Therefore, in order to solve the above-mentioned problem, permission to dust etc. needed to be made large and the front face of the electrode which becomes the substrate of an organic layer needed to be made to graduate by making thickness of an organic layer to some extent thick.
[0019] However, if the CuPc organic film formed on the transparence electric conduction film especially as an organic layer is thickened as mentioned above, a voltage-current property and an electrical-potential-difference-brightness property will shift to a high-voltage side. consequently, the thing before thickening thickness of the CuPc organic film -- ** -- in order to make light emit by the same brightness, higher driver voltage is needed and the problem that the consumption of power increases is caused.
[0020] Furthermore, since many of luminescence will be absorbed by the CuPc organic film when it has the absorption band to the red field and many red components are contained in luminescence of a luminous layer, since the CuPc organic film which formed membranes by molecular beam deposition is green, the brightness of sufficient red luminescence is not obtained.
[0021] Therefore, it is hard coming to pass the light of the red in the CuPc organic film, or a green component by the configuration that the CuPc organic film was contained in the organic layer, so that the thickness of the CuPc organic film becomes thick. consequently, green -- more -- a long wave -- the brightness of merit's component cannot fall, even when it is going to obtain white luminescence, it cannot become blue, and the desired luminescent color cannot be obtained.
[0022] by the way -- although the CuPc film which constitutes a part of organic layer shows p form conduction -- this CuPc film -- for example, NO2 etc. -- adsorption of gas with powerful electronic

receptiveness (oxidizing quality) knows that the gas molecule has the property in which generate an electron hole in reception and the film and membranous conductivity rises the pi electron of the annular atomic group of the CuPc film.
[0023] Then, even if it uses the property of the CuPc film mentioned above and thickens thickness of the CuPc organic film, this invention attains low-power-ization, and a drive on a lower electrical potential difference is possible for it, and it aims at offering the organic EL device which the permeability of the light red section of the CuPc organic film can be raised, and can obtain the desired luminescent color, and its manufacture approach.
[0024]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention of claim 1 is characterized by said CuPc organic film consisting of film containing the gas of the electronic receptiveness formed by the ion plating method by thickness 1000nm or more in the organic EL device with which the laminating of the organic layer which contains the CuPc organic film of hole impregnation nature in inter-electrode [of the pair which one / at least / electrode becomes by the transparence electric conduction film] was carried out.
[0025] invention of claim 2 -- the organic EL device of claim 1 -- setting -- the gas of said electronic receptiveness -- NO2 from -- it is characterized by becoming.
[0026] Invention of claim 3 is characterized by to include the process which carries out rinse processing of the front face of this CuPc organic film by the gas of electronic receptiveness, after the organic layer which contains the CuPc organic film of hole impregnation nature in inter-electrode [of the pair which one / at least / electrode becomes by the transparence electric conduction film] forms said CuPc organic film by 1000nm or more of thickness by the ion plating method in the manufacture approach of the organic EL device by which the laminating was carried out and said CuPc organic film is formed.
[0027] In the manufacture approach of an organic EL device that the laminating of the organic layer to which invention of claim 4 contains the CuPc organic film of hole impregnation nature in inter-electrode [of the pair which one / at least / electrode becomes by the transparence electric conduction film] was carried out It is characterized by including the process which divides said CuPc organic film into two or more layers, and forms membranes by 1000nm or more of thickness by the ion plating method, and the process which carries out rinse processing of the front face by the gas of electronic receptiveness whenever it forms each class of said CuPc organic film.
[0028]
[Embodiment of the Invention] The partial expansion sectional side elevation showing the gestalt of the 1st operation of the organic EL device according [drawing 1] to this invention and drawing 2 (a) - (i) are the sectional side elevations showing the production process of the organic EL device of drawing 1 .
[0029] As shown in drawing 1 , organic EL device 1A (1) by the gestalt of the 1st operation makes the base the glass substrate 2 of the shape of a rectangle which has insulation and transparency. On the glass substrate 2, the transparence electric conduction film 3, such as ITO, is formed. the transparence electric conduction film 3 -- for example, PVD(s) (Physical Vapor Deposition), such as a vacuum deposition method and a spatter, -- membranes are formed by law by the thickness around 100nm. Pattern NINGU of the transparence electric conduction film 3 is further carried out by etching by the photoresist pattern at a predetermined pattern configuration, and it forms the anode plate 4. A part of anode plate 4 is pulled out to the edge of a glass substrate 2, and it is connected to a non-illustrated drive circuit (driver IC).
[0030] On the anode plate 4, the laminating of the organic layer 5 containing the luminous layer by the thin film of an organic compound ingredient is carried out. The organic layer 5 is formed by PVD, such as for example, molecular-beam vacuum deposition and a resistance heating method.
[0031] CuPc organic film 5a as hole impregnation nature organic film with which the organic layer 5 in drawing 1 was formed by thickness 1000nm or more on the anode plate 4, Alq3 as electronic [a luminous layer-cum-] transportability organic film formed by several 10nm thickness on alpha-NPD organic film 5b as hole transportability organic film formed by several 10nm thickness on CuPc organic film 5a, and alpha-NPD organic film 5b It is formed by the three-tiered structure with organic film 5c.
[0032] On the organic layer 5, the cathode 6 by the metal thin film is formed. Cathode 6 consists of a small alloy of work functions, such as a metallic material simple substance with small work functions, such as aluminum, Li, Mg, Ag, and In, and aluminum-Li, Mg-Ag. Cathode 6 is formed by PVD, such as for example, molecular-beam vacuum deposition and a resistance heating method, by the thickness of

several 10nm - 100nm of numbers (preferably 50nm - 200nm). Some cathode 6 is pulled out to the edge of a glass substrate 2, and it is connected to a non-illustrated drive circuit.

[0033] Into the periphery part of a glass substrate 2, the container section 7 of the shape of a lid as a sealing member has fixed with adhesives (for example, ultraviolet curing adhesives) in the dry ambient atmosphere by inert gas (for example, dry nitrogen) and the dried air which removed moisture as much as possible. Thereby, while protecting two electrodes 4 and 6 and the organic layer 5, the high definition organic electroluminescence device is realized.

[0034] In organic EL device 1A constituted as mentioned above, driver voltage is impressed from a non-illustrated drive circuit between an anode plate 4 and cathode 6, and constant current is passed. Thereby, an electron is poured in for a hole from cathode 6 from an anode plate 4 to the organic layer 5, respectively. And the hole and electron which were poured in recombine in the organic layer 5, an exciton is generated, and a desired display is made by emission of the light at the time of this exciton deactivating. Luminescence in that case is observed from the outside of a glass substrate 2 through the anode plate 4 by the transparence electric conduction film.

[0035] Next, the manufacture approach of organic EL device 1A by the above-mentioned configuration is explained based on drawing 2 (a) - (i). First, internal pressure sets a glass substrate 2 in the chamber which is not illustrated [which was set as 10 - 5 or less Pa], and forms the transparence electric conduction film 3 by about 150nm thickness on the front face of a glass substrate 2 (drawing 2 (a)). Then, etching by the photoresist pattern is performed to the transparence electric conduction film 3, and the anode plate 4 of a predetermined pattern configuration is formed (drawing 2 (b)). Although this transparence electric conduction film 3 can be formed by the usual spatter, since the irregularity of the shape of a flake to which the transparence electric conduction film 3 Pori-ized, and originated in the grain boundary in membrane formation by the spatter will be formed in a front face, it is desirable that it is noncrystalline and membranes are formed. For example, if the transparence electric conduction film 3 is formed by the amorphous transparence electric conduction film of IDIXO (trade name: Idemitsu transparence electrical conducting material Idemitsu Indium X-Metal Oxide, Idemitsu Kosan, Inc. make), it is precise and the film excellent in surface smooth nature can be formed.

[0036] In addition, in order to carry out desired pattern NINGU at the time of membrane formation of the transparence electric conduction film (transparence electric conduction film by IDIXO etc.) 3 twisted amorphously, mask vacuum evaporationo may be carried out. Moreover, after membrane formation of the transparence electric conduction film 3, the usual photolithography method may be used depending on the case, and pattern processing of the transparence electric conduction film 3 may be carried out.

[0037] After the anode plate 4 by the transparence electric conduction film 3 is formed, CuPc organic film 5a is formed by thickness 1000nm or more on an anode plate 4 (drawing 2 (c)). For example, when forming CuPc organic film 5a of 1000nm thickness, membranes are formed by PVD, such as molecular-beam vacuum deposition and a resistance heating method, in 10 steps by 100nm [per time] thickness.

[0038] The ion plating system shown in drawing 3 is used for membrane formation of the above-mentioned CuPc organic film 5a. The ion plating system 11 has the vacuum tub 12 which makes the interior a desired vacuum ambient atmosphere using the exhaust air means which is not illustrated. The substrate electrode holder 13 is formed in the upper part of the vacuum tub 12. The substrate electrode holder 13 holds the glass substrate 2 for making CuPc organic film 5a deposit removable. The substrate bias power supply 14 is connected to this substrate electrode holder 13, and it is constituted so that the plasma mentioned later may be accelerated and it can draw near to a glass substrate 2. The heating means 15 is installed in the lower part of the vacuum tub 12. The source 17 of vacuum evaporationo is put in in the boat 16 which consists of W, Mo, etc., and if it lays on this heating means 15 and heats, the source 17 of vacuum evaporationo will evaporate with heat. The coil electrode 18 is arranged at the upper part flank of the heating means 15 in the vacuum tub 12. The RF power source 20 is connected to the coil electrode 18 through the matching circuit 19, energy can be given to a nearby molecule and the plasma can be generated. The gas installation tubing 22 is connected to the vacuum tub 12 through the gas installation valve 21, and only a desired amount can introduce a desired controlled atmosphere now into the interior.

[0039] CuPc organic film 5a is formed on the transparence electric conduction film 3 of a glass substrate 2 using said ion plating system 11. First, the boat 16 of W or Mo is installed in the heating means 15 in the vacuum tub 12. CuPc is put in in this boat 16. The inside of the vacuum tub 12 is exhausted so that it may become the degree of vacuum of 10 to 5 or less Torrs. Next, it energizes for the heating means 15, a boat

16 is heated in temperature of about 400-500 degrees C, and CuPc is evaporated. At this time, the gas installation valve 21 is operated, gas, such as Ar, is introduced into the vacuum tub 12, a degree of vacuum is set to 10-1 to 10 to 4 or more Torrs, high-frequency power is impressed to the coil electrode 18, and the plasma is generated. If the acceleration voltage not more than 500V is impressed to the substrate electrode holder 13, plasma-ized CuPc will move towards the glass substrate 2 attached in the substrate electrode holder 13, will accumulate on the transparence electric conduction film 3 of a glass substrate 2, and will generate CuPc organic film 5a as plasma polymerization film.

[0040] When CuPc organic film 5a is formed as mentioned above, it is N2 as 1st gas rinse processing of CuPc organic film 5a in the chamber to which the glass substrate 2 was set. Gas is introduced and aged (drawing 2 (d)). Concretely, by this 1st gas rinse processing, it is N2. Gas is introduced until chamber internal pressure is set to 10-100Pa by the flow rate of for example, 100 ml/mn, and it is left for 5 minutes. It is NO2 with strong electronic receptiveness by this 1st gas rinse processing. It is NO2 suddenly not to introduce gas. When gas is introduced in a chamber, it is because there is a possibility of reacting with the residual gas in a chamber and causing explosion etc.

[0041] It is NO2 in a chamber as 2nd gas rinse processing of CuPc film 5a succeedingly to the above-mentioned 1st gas rinse processing. Gas is introduced and it is N2. It is gas NO2 It permutes by gas (drawing 2 (e)). Concretely, by this 2nd gas rinse processing, it is NO2. Gas is introduced until chamber internal pressure is set to 10-100Pa by the flow rate of for example, 100 ml/mn, and it is left for 10 minutes. Thereby, it is NO2 in a chamber. CuPc organic film 5a is made to contact in the condition of not putting gas to atmospheric air immediately after membrane formation. And it is NO2 to the front face of CuPc organic film 5a. Gas is made to adsorb enough and it is NO2 in the film. Gas is made to permeate.

[0042] After finishing the above-mentioned 2nd gas rinse processing, where it carried out evacuation of the inside of a chamber again and chamber internal pressure is set to 10 - 5 or less Pa, alpha-NPD organic film 5b is formed by PVD, such as molecular-beam vacuum deposition and a resistance heating method, on CuPc organic film 5a (drawing 2 (f)). Then, it is Alq3 on alpha-NPD organic film 5b. Organic film 5c is formed (drawing 2 (g)), and it is Alq3 further. The metal thin film (for example, aluminum-Li film) used as cathode 6 is formed by PVD on organic film 5c (drawing 2 (h)).

[0043] Then, in the ambient atmosphere by inert gas (for example, dry nitrogen) and the dried air which removed moisture as much as possible, the container section 7 as a sealing member is fixed with ultraviolet curing adhesives into the periphery part of a glass substrate 2 (drawing 2 (i)). Thereby, an anode plate 4, the internal organic layer 5, and internal cathode 6 are protected, and organic EL device 1A is completed.

[0044] Next, drawing showing the gestalt of the 2nd operation of the organic EL device according [drawing 4] to this invention and drawing 5 (a) - (j) are drawings showing the production process of the organic EL device of drawing 4 . In addition, the same number is given to the same component as the gestalt of the 1st operation, and the explanation is omitted.

[0045] Organic EL device 1B of the gestalt of the 2nd operation is NO2 to the front face of each class, whenever CuPc organic film 5a formed on an anode plate 4 divides into two or more layers, and is formed by PVD, such as molecular-beam vacuum deposition and a resistance heating method, and each class is formed. It has the composition of making gas adsorbing enough. About other configurations, it is the same as that of organic EL device 1A of the gestalt of the 1st operation.

[0046] In manufacturing the above-mentioned organic EL device 1B, a process until it forms the 1st layer of CuPc organic film 5a is performed at the same process as the case where organic EL device 1A of the gestalt of the 1st operation mentioned above is manufactured (drawing 5 (a) - (c)).

[0047] When the 1st layer of CuPc organic film 5a is formed on an anode plate 4 by the ion plating method mentioned above, it is N2 as 1st gas rinse processing in the chamber to which the glass substrate 2 was set. Gas is introduced and aged (drawing 5 (d)). Concretely, by this 1st gas rinse processing, it is N2. Gas is introduced until chamber internal pressure is set to 10-100Pa by the flow rate of for example, 100 ml/mn, and it is left for 5 minutes.

[0048] It is NO2 in a chamber as 2nd gas rinse processing succeedingly to the above-mentioned 1st gas rinse processing. Gas is introduced and it is N2. It is gas NO2 It permutes by gas (drawing 5 (e)). Concretely, by this 2nd gas rinse processing, it is NO2. Gas is introduced until chamber internal pressure is set to 10-100Pa by the flow rate of for example, 100 ml/mn, and it is left for 10 minutes. Thereby, it is NO2 in a chamber. The 1st layer of CuPc organic film 5a is made to contact in the condition of not

putting gas to atmospheric air immediately after membrane formation. And it is NO2 to the front face of CuPc organic film 5a. Gas is made to adsorb enough and it is NO2 in the film. Gas is made to permeate.

[0049] After finishing the above-mentioned 2nd gas rinse processing, the two-layer eye of CuPc organic film 5a is formed on the 1st layer by the ion plating method. Whenever each class is formed, the above-mentioned 2nd gas rinse processing is performed until CuPc organic film 5a is formed by the thickness (1000nm or more) considered as a request about the two-layer eye of this CuPc organic film 5a or subsequent ones (drawing 5 (f)).

[0050] That is, in the count of membrane formation, if thickness formed by M (nm) (however, M> 0nm) and per time in the thickness of CuPc organic film 5a considered as a request is set to H (nm), N will be formed so that the relation of H-N>=M may be satisfied. If the thickness from which the thickness of the CuPc organic film considered as a request is concretely formed by per time by 1000nm is 100nm, the CuPc organic film will be formed in 10 steps. And whenever it finishes this ten membrane formation, the above-mentioned 2nd gas rinse processing is performed.

[0051] After CuPc organic film 5a of the thickness considered as a request is formed and finishing the above-mentioned 2nd gas rinse processing for each class, where it carried out evacuation of the inside of a chamber again and chamber internal pressure is set to 10 - 5 or less Pa, alpha-NPD organic film 5b is formed by PVD, such as molecular-beam vacuum deposition and a resistance heating method, on CuPc organic film 5a (drawing 5 (g)). Then, it is Alq3 on alpha-NPD organic film 5b. Organic film 5c is formed (drawing 5 (h)), and it is Alq3 further. The metal thin film (for example, aluminum-Li film) used as cathode 6 is formed by PVD on organic film 5c (drawing 5 (i)).

[0052] Then, in the ambient atmosphere by inert gas (for example, dry nitrogen) and the dried air which removed moisture as much as possible, the container section 7 as a sealing member is fixed with ultraviolet curing adhesives into the periphery part of a glass substrate 2 (drawing 5 (j)). Thereby, an anode plate 4, the internal organic layer 5, and internal cathode 6 are protected, and organic EL device 1B is completed.

[0053] Thus, CuPc organic film 5a which constitutes a part of organic layer 5 according to the organic EL device 1 (1A, 1B) of the gestalt of each above-mentioned implementation is NO2 as gas with powerful electronic receptiveness (oxidizing quality). Since it contains, the conductivity of CuPc organic film 5a rises, it can be stabilized and hole injection efficiency can be raised. Thereby, the threshold of the current in a voltage-current property can be shifted to a low-battery side. Consequently, when carrying out the dynamic drive of the organic EL device 1, it becomes possible to set the electrical potential difference for obtaining desired brightness as a low battery, and the cost cut of a drive circuit (driver IC) can be aimed at. And since an organic EL device 1 can be driven by the low battery, the life property under lighting is also improvable.

[0054] Here, the voltage-current property and electrical-potential-difference-brightness property in the organic EL device of the gestalt (gestalt of the 2nd operation) of this operation when setting thickness of the CuPc organic film to 1000nm and the conventional organic EL device are shown in drawing 6 and drawing 7 .

[0055] When it compares based on drawing 6 and drawing 7 about each property of the organic EL device of the gestalt of this operation, and the conventional organic EL device, it is 2 15mA/cm to an organic EL device first. When passing a current, as shown in drawing 6 , the driver voltage is set to about 8.5 V by organic EL device 1B of the gestalt of this operation whose thickness of the CuPc organic film is 1000nm.

[0056] On the other hand, in the conventional organic EL device whose thickness of the CuPc organic film is 1000nm, driver voltage still higher than the organic EL device of the gestalt of the above-mentioned implementation is needed so that clearly also from drawing 6 .

[0057] Moreover, 400 cd/m2 In obtaining brightness, as shown in drawing 7 , with the organic EL device of the gestalt of this operation whose thickness of the CuPc organic film is 1000nm, the driver voltage turns into driver voltage which is about 9V.

[0058] On the other hand, in the conventional organic EL device whose thickness of the CuPc organic film is 1000nm, driver voltage still higher than the organic EL device of the gestalt of the above-mentioned implementation is needed so that clearly also from drawing 7 .

[0059] Thus, when thickness of the CuPc organic film is set to 1000nm and the same current or the same brightness compares, according to the organic EL device of the gestalt of this operation, it turns out that the voltage-current property of drawing 6 and the electrical-potential-difference-brightness property of

drawing 7 can be shifted to a low-battery side rather than the conventional organic EL device.

[0060] Therefore, when thickness of the CuPc film is made into the same thickness, according to the organic EL devices 1A and 1B of the gestalt of each operation, it can drive on an electrical potential difference lower than the conventional organic EL device, and reduction of power consumption can be aimed at.

[0061] Drawing 8 is drawing showing the relation between the wavelength in the CuPc organic film of the organic EL device of the gestalt of this operation, and the CuPc organic film of the conventional organic EL device, and permeability. In drawing 8 , a continuous line is a permeability curve which formed the CuPc organic film by 1000nm thickness by the ion plating method concerning the gestalt of this operation, and a broken line is a permeability curve when forming the CuPc organic film by 1000nm thickness by PVD, such as the conventional molecular-beam vacuum deposition and a resistance heating method.

[0062] Even if it sees this drawing 8 , in the red field, the peak of permeability shows 0.05 by the conventional CuPc organic film to the peak of permeability showing 0.95 by the CuPc organic film of the gestalt of this operation so that clearly. From this, the permeability in a red field is improving sharply compared with the former in CuPc organic film 5a which formed membranes by the ion plating method of the gestalt of this operation. Since the interaction between the CuPc molecules which a crystallized state changes and approaches by the plasma polymerization decreased, and the obliterating power as a pigment declined, this is considered. Moreover, according to the in plaiting method performed by impressing high-frequency power, the irregularity of the front face of the deposited plasma polymerization film becomes small, and becomes smooth, and its reactive current which does not contribute to luminescence for this reason decreases.

[0063] Thus, with the gestalt of this operation, since it is a plasma polymerization layer with the high permeability which CuPc organic film 5a formed by the ion plating method in addition to the gas rinse processing mentioned above, red luminescence can become is hard to be absorbed, the permeability of red luminescence can be raised, and the desired luminescent color can be obtained. Moreover, since the front face of formed CuPc organic film 5a becomes smoother than the usual vacuum evaporationo film, the reactive current which does not contribute to luminescence can be decreased.

[0064] According to organic EL device 1B of the gestalt of the 2nd operation, CuPc organic film 5a is NO2 for each class. The concentration of the gas molecule in the upper layer and the lower layer of CuPc film 5a becomes uniform, since it has multilayer structure which adsorbed gas, and it is NO2 of the direction of thickness of CuPc film 5a. The inclination of gas molecule concentration (distribution of the point of CuPc organic film 5a in drawing 1 and drawing 4), i.e., the variation of gas molecule concentration, can be lost.

[0065] In addition, in the gestalt of the above-mentioned implementation, in order to be influenced by the concave convex of the transparence electric conduction film 3 if thickness of CuPc organic film 5a is made thin when the substrate of CuPc organic film 5a is the transparence electric conduction film, data smoothing of the transparence electric conduction film 3 is needed. It is possible to grind and graduate a front face after membrane formation of the transparence electric conduction film 3, such as ITO, as this data smoothing, or to form the transparence electric conduction film 3 with amorphous substances, such as IDIXO.

[0066] By the way, by the manufacture approach of the gestalt each operation mentioned above, it is N2. The 1st gas rinse processing of gas, and NO2 Although explained as what performs the 2nd gas rinse processing of gas at a separate process, it is N2, for example. : Gas rinse processing may be performed using the mixed gas by the ratio of NO 2 = 98:2. Thereby, it is N2 of the above-mentioned CuPc film 5a. The 1st gas rinse processing of gas, and NO2 It can realize at one process, without dividing the 2nd gas rinse processing of gas.

[0067] The organic layer 5 in the gestalt of each operation should just be structure which is not limited to the three-tiered structure of illustration and contains CuPc organic film 5a as hole impregnation nature organic film, and a luminous layer.

[0068] In the gestalt of each operation, it is good also as a configuration which reversed the cathode 6 which consists of an anode plate 4 which consists of transparence electric conduction film 3, and a metal thin film. In this case, CuPc organic film 5a which constitutes the organic layer 5, alpha-NPD organic film 5b, and Alq3 The laminating also of the organic film 5c is reversed and carried out. In that case, the

glass substrate 2 used does not necessarily need to have transparency, and can use the colored substrate which has insulation.
[0069] Moreover, the electrode (an anode plate 4, cathode 6) of a pair should just be formed with the electrical conducting material with which at least one side has transparency. In that case, in the case of the electrical conducting material with which both electrodes have transparency, the electrical conducting material (ITO) which has the large transparency of a work function is used for one electrode (anode plate 4), and the electrical conducting material which has the small transparency of a work function in the electrode (cathode 6) of another side is used.
[0070]
[Effect of the Invention] Since the CuPc organic film which constitutes a part of organic layer according to the organic EL device of this invention so that clearly contains the gas (NO2) of electronic receptiveness, the conductivity of the CuPc organic film rises at the above explanation, it can be stabilized and hole injection efficiency can be raised.
[0071] Thereby, the threshold of the current in a voltage-current property can be shifted to a low-battery side. Consequently, when carrying out the dynamic drive of the organic EL device, it becomes possible to set the electrical potential difference for obtaining desired brightness as a low battery, and the cost cut of a drive circuit can be aimed at. And since an organic EL device can be driven by the low battery, the life property under lighting is also improvable. In addition, since the CuPc organic film is a plasma polymerization layer with the high permeability formed by the ion plating method, red luminescence can become is hard to be absorbed, it can raise the permeability of red luminescence, and can obtain the desired luminescent color. Moreover, since the front face of the CuPc organic film formed by the ion plating method becomes smoother than the usual vacuum evaporationo film, the reactive current which does not contribute to luminescence can be decreased.
[0072] Whenever it divides the CuPc organic film into two or more layers, it forms membranes and it forms each class especially, by carrying out rinse processing of the front face by the gas (NO2) of electronic receptiveness, the concentration of the gas molecule in the upper layer and the lower layer of the CuPc film becomes uniform, and the variation in the gas molecule concentration of the direction of thickness of the CuPc film can be abolished.

[Translation done.]